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(54) Title of the Invention
Electronic parts joining material and electronic equipment using said material

(57) Abstract

Purpose:
To provide electronic parts joining material with which conductivity failure does not occur even when the usage environment temperature rises and the insulating resin base material increases in volume.

Constitution:
The electronic parts joining material in this invention disperses/contains conductive memory alloy particles 3 within insulating resin base material 2.

Claims

Claim 1
In electronic parts joining material comprising dispersing/containing conductive particles within insulating resin base material, electronic parts joining material characterized by using conductive shape memory alloy particles as said conductive particles.

Claim 2
Electronic parts or electronic equipment characterized by having a joint comprising electrically joining with an electronic parts joining material in Claim 1.

Detailed Description of the Invention

0001
Industrial Field of Application

This invention relates to electronic parts joining material used for a joint of electronic equipment etc. used in an environment generating a heat cycle, and to electronic equipment using said [material].

0002
Prior Art
Conventionally, metal joining material such as solder is used to join pins etc. of electronic parts and electronic equipment. However, metal joining material such as solder has a high melting point necessitating a high temperature procedure at around 300°C. Such a high temperature procedure entails the risk of causing heat deterioration in the electronic parts and electronic equipment. Also, because metal joining material such as solder lacks flexibility in response to an external force, when a joint is subjected to impact during a manufacturing process or during transport, the joint could separate, risking causing conductivity failure.

0003
To resolve these problems with metal joining material such as solder, an electronic parts joining material 11 shown in Figure 4 is used, comprising conductive particles 5μm to 20μm in size, such as carbon particles, metal particles such as solder or nickel, resin balls with a conductive coating formed on their surface, etc., dispersed/contained within an insulating resin base material 12 with 20μm to 30μm layer thickness, such as thermoplastic resin (polyester, polyethylene) or thermosetting resin (epoxy resin), etc.

0004
As shown in Figure 5, circuit boards are mutually connected using said electronic parts joining material 11 by sandwiching this electronic parts joining material 11 between a wiring pattern 14a on a circuit board 14 and a wiring pattern 15a on a circuit board 15, applying heat and pressure for 20 to 40 seconds at 150°C to 170°C temperature and 10kg/cm^2 to 30kg/cm^2 pressure, pressure welding conductive particles 13 to the wiring pattern 14a and the wiring pattern 15a by compressing [said particles] to 1μm to 3μm, thus securing conductivity between [said patterns]. Thus, in a connection of circuit boards using said electronic parts joining material 11, because mechanical strength of the joint is attained by the adhesion strength of an insulating resin base material 12, the joint has more flexibility compared to a joint using metal joining material such as solder. Therefore, even when a joint is subjected to impact during a manufacturing process or during transport, there is no risk of joint separation causing conductivity failure.

0005
However, the conductive particles 13 have lost their reversion force due to plastic deformation from said pressure application operation. And when the insulating resin base material 12 is used in an environment generating a heat cycle, its volume increases when the temperature increases. However, because the conductive particles 13 within the insulating resin base material 12 have lost their reversion force as stated above, and because their heat expansion coefficient is smaller than that of the insulating resin base material 12, a small gap δx forms between the wiring pattern 14a and the wiring pattern 15a, causing a conductivity failure. Also, because the conductive particles 13 have lost their reversion force as stated above, there is a problem of lacking vibration tolerance.

0006
Problem the Invention is to Solve

This invention seeks to resolve these problems with prior art, and its main purpose is to provide an electronic parts joining material, and electronic parts and electronic equipment using said material, which generate no conductivity failure due to gap formation between conductive bodies even when used in an environment generating a heat cycle, and which improve joint vibration tolerance.

0007
Means for Solving the Problem

The electronic parts joining material in this invention is characterized by, in electronic parts joining material comprising dispersing/containing conductive particles within insulating resin base material, using conductive shape memory alloy particles as said conductive particles.

0008
Also, electronic parts or electronic equipment in this invention are characterized by having a joint comprising electrically joining with said electronic parts joining material.

0009
Action

Because the electronic parts joining material in this invention disperses/contains conductive shape memory alloy particles within an insulating resin base material, [said particles] deform in accordance with the volume increase of the insulating resin base material because of the shape reversion force of the contained shape memory alloy (hereafter simply "reversion force"). This prevents the occurrence of a gap or a crack between the conductive bodies. Therefore, the joint conductivity condition can be favorably maintained. Also, shape memory alloy has elasticity even during usage conditions, which enables improving joint vibration tolerance.

0010
The joints of the electronic parts or electronic equipment in this invention (hereafter collectively "electronic equipment") are joined by said electronic parts joining material, and thus conductivity failures do not occur even when used in an environment generating a heat cycle, and [said joints have] superior vibration tolerance. Therefore, reliability is high.

0011
Embodiments
This invention is described below based on embodiments, referencing the attached drawings. However, this invention is not limited to said embodiments.

0012
Figure 1 is a summary drawing of one embodiment of the electronic parts joining material of this invention. Figure 2 is a drawing explaining the usage status of the electronic parts joining material of this invention. Figure 3 is a drawing explaining the principle of securing conductivity in [using] the electronic parts join material of this invention. In these Figures, 1 is electronic parts joining material, 2 is insulating resin base material, 3 is conductive shape memory alloy particles, 4 is one circuit board, and 5 is another circuit board.

0013
For the insulating resin base material 2 of the electronic parts joining material 1 of this invention, a wide [range] of insulating resin can be used which, when used in a joint for electronic equipment, etc., does not melt at the temperature to which the joint is subjected, and which has an adhesive property to metals. Specific examples could include resins conventionally used for electronic parts joining material, such as epoxy resins and other thermosetting resins, or polyester, polyethylene, and other thermoplastic resins. Of these, those appropriately hardening within a temperature range of about 25 to 175°C are preferable, because they do not cause heat deterioration of electronic equipment.

0014
For conductive shape memory alloys, various types of Ti-Ni, Ag-Cd, Au-Cd, Cu-Au-Zn, In-Tl, In-Cd, and Ti-Ni-Cu shape memory alloys can be favorably used. Of these, those having a critical temperature which begins shape memory action (hereafter, simply "critical temperature") within a temperature range of 25 to 200°C are preferable. Here, this shape memory alloy is dispersed within the insulating resin base material 2 as particles 3, and there are no particular restrictions regarding granule diameter or dispersion density, which can be selected as appropriate. Also, initial distortion could be performed before [particle] dispersion. In this case, for example, if the initial shape is spherical with a diameter of d and is deformed into a rugby ball shape after applying initial distortion, n/d should be 0.2 to 0.9, and preferably 0.4 to 0.6. When dispersing these granules 3 in the insulating resin base material 2, the critical temperature [of the granules] should be approximately equal to or higher than the hardening temperature of the resin base material 2, and the temperature difference between the two should preferably be 30°C or less. The temperature difference between the two is thus set because, if the critical temperature is too high compared to the hardening temperature of the resin base material 2, the shape memory alloy shape reversion action begins after the resin hardening is nearly complete, and the shape memory alloyed particles 3 will not sufficiently revert, which could cause conductivity failures.

0015
The form of the electronic part joining material in this invention can be simply in tape form, or a tape in which indentations are preformed to match the joint pattern for the applicable electronic machinery. Also, this can be in paste form (gel form).

0016
Next, referencing Figure 2, a situation is described using a tape form of the electronic parts joining material 1 of this invention to join a flat liquid crystal display panel and an external connection circuit, which is conventionally commonly joined using electronic parts joining material. Here, the layer thickness of the insulating resin base material 2 is about 20 to 30μm, and the diameter of the shape memory alloy particles 3 is about 5 to 20μm.

0017
First, in the conventional manner, this electronic parts joining material 1 in tape form is sandwiched between the wiring pattern 4a of the circuit board 4 and the wiring pattern 5a of the circuit board 5, and heat and pressure are applied for a specified time. The heating temperature used is a temperature in the vicinity of the insulating resin base material 2 hardening temperature, for example 150°C to 170°C, and the pressure is 10kg/cm^2 to 30kg/cm^2. Also, said specified time is, for example, 20 seconds to 40 seconds. This application of heat and pressure compresses the conductive shape memory alloy particles 3 to about 1μm to 3μm, pressure welding to the wiring pattern 4a and the wiring pattern 5a, thus securing conductivity between both. After this, the connected circuit boards 4 and 5 are heated to a temperature at which shape reversion action of the shape memory alloy begins, for example 180°C.

0018
As a result, as shown in Figure 3, the compressed conductive shape memory alloy particles 3 attempt to resume their original shape, which applies pushing pressure in the directions of the arrows in the figure. Therefore, even when the insulating resin base material 2 volume increases upon a heat-cycle-induced increase in usage environment temperature, the reversion force of the particles 3 causes them to deform to enlarge in the vertical direction in the figure, securing constant contact between the wiring pattern 4a and the wiring pattern 5a. Thus, no conductivity failures occur caused by gap formation. Also, because the particle 3 are in the condition described above, no conductivity failures occur caused by external excitation.

0019
When using electronic parts joining material 1 in which particles 3 having preformed initial distortion are dispersed, pressure application at said high pressure becomes unnecessary, allowing joining at a low pressure.

0020
In another embodiment of this invention (hereafter "second embodiment"), the insulating resin base material 2 is in paste form (gel form). In this second embodiment, the material for the insulating resin base material 2, the particle diameter for the shape memory alloy particles 3 dispersed/contained [therein], and the dispersion density are identical to the previous embodiment, except that the insulating resin base material is in paste form.

0021
Next, bonding a chip for electronic parts such as surface mounted diodes and transistors is explained, according to this second embodiment. In this case, it is preferable to preform initial distortion into the shape memory alloy particles 3, because applying excessive pressure to a chip risks causing component damage.

0022
First, electronic parts joining material 1 in paste form is applied or printed in a specified thickness onto a specified portion of the leads. Here, a thickness larger than the particles 3 particle diameter is sufficient (when initial distortion is applied, the particle diameter after said [distortion] application). Next, leads with electronic parts joining material 1 applied in paste form are located in a specified position on a chip. Heat is applied in this condition to reach the hardening temperature of the insulating resin base material 2 of the electronic parts joining material 1. In this case, appropriate pressure is applied as desired. Thereafter, heat is applied to the critical temperature for the shape memory alloy particles 3. This heating may be performed consecutively with the previous heating.

0023
The action and effects expressed by this second embodiment are also identical to the prior embodiment. However, because the insulating resin base material 2 is in paste form, the scope of application is expanded.

0024
This invention has been described above based on two embodiments, but the application of the electronic parts joining material in this invention is not limited to said [embodiments], but can be favorably used for joining various types of electronic parts, or for mounting and structuring electronic equipment. For example, this can be favorably applied to joining a semiconductor element to a lead frame for electronic parts including surface mounted types and lead types etc.; or to joining electrodes on electronic parts to a circuit board wiring pattern when mounting electronic parts including surface mounted types and lead types etc., flat display elements, thermal printing heads, etc. onto a circuit board (including flexible boards); or to joining hybrid IC, flat display elements, thermal printing heads, etc. to contact pins.

0025
Effects of the Invention

As described above, by connecting using the electronic parts joining material in this invention, good conductivity is always secured even in an environment generating a heat cycle or in an environment with excitation applied. Also, the electronic parts joining material in this invention also provides the effect of enabling performing procedures at relatively low temperatures.

0026
Meanwhile, electronic equipment having joints using the electronic parts joining material of this invention have good conductivity even in an environment generating a heat cycle or in an environment with excitation force applied, thus improving product reliability for thermal printing heads, etc.

Brief Description of the Drawings

Figure 1
This is a summary drawing of the electronic parts joining material of this invention.
Figure 2
This is a drawing explaining the usage status of the electronic parts joining material of this invention.
Figure 3
This is a drawing explaining the principle of securing conductivity in [using] the electronic parts joining material of this invention.
Figure 4
This is a summary drawing of conventional electronic parts joining material.
Figure 5
This is a drawing explaining the usage status of conventional electronic parts joining material.
Figure 6

This is a drawing explaining the principle of conductivity failures occurring in [using] conventional electronic parts joining material.

Reference Numbers

1	Electronic parts joining material
2	Insulating resin base material
3	Conductive shape memory alloy granules
4	One circuit board
5	Other circuit board

[see original for drawings]

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6